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(54) **Automatic gearboxes having centrifugal clutches**

(57) The gearbox includes an input shaft (2) and an output shaft (4), the input shaft (2) carrying a first input gear wheel (6) connected to rotate with it. Second, third and fourth gear wheels, (8, 10 and 12) extend around the input shaft (2) and are carried by respective coaxial annular secondary shafts (14, 16 and 18) which are rotatable with respect to the input shaft and with respect to each other. The secondary shaft (14) of the second input gear (8) is connected to rotate with the outer half (56) of a first load-sensitive centrifugal clutch (22) and the remaining secondary shafts are connected to rotate with the inner members (24 and 26) respectively of second speed-sensitive centrifugal clutches (28, 30). The outer drum 20 of the first centrifugal clutch is connected to rotate with the input shaft 2. The outer drums of all the second centrifugal clutches are connected to rotate together and constitute a single unit (74). One-way clutches (46) are provided which prevent relative rotation of output gear wheels (32, 34, 36, 38) in the other direction. The first centrifugal clutch (22) includes fly weights (56) which are urged outwardly by centrifugal force to transmit torque between its inner members and its outer drum (2). Adjustable resistance means, such as springs (58), exert a force in opposition to the centrifugal force whose magnitude is a function of the torque transmitted by input shaft (2).

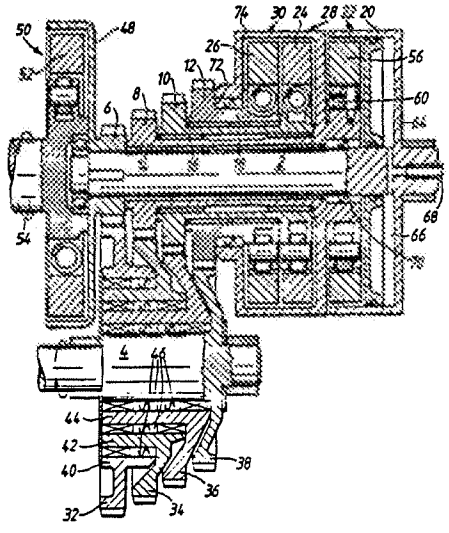

FIG.1.

The drawing(s) originally filed was (were) informal and the print here reproduced is taken from a later filed formal copy.

The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1982.

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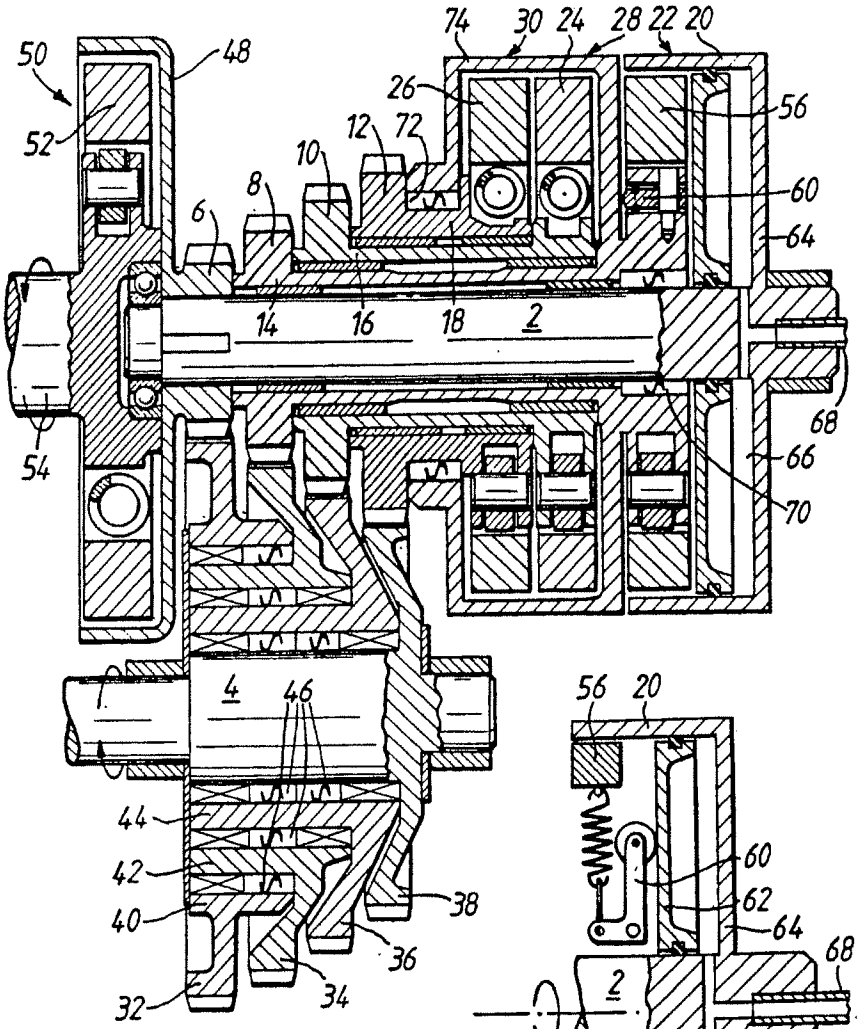
74
30
24
28
22
20
50
48
26
56
52
12
72
10
8
60
6
64
14
16
18
2
68
54
66
70
4
46
44
42
38
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FIG.1.

56
20
60
62
64
68
2
66
58
22

FIG.2.

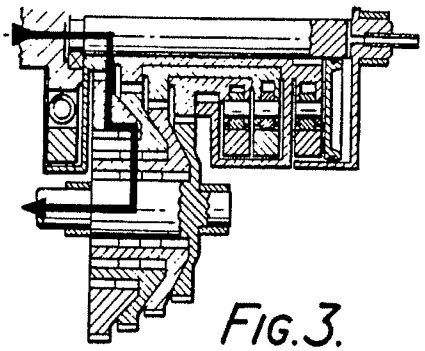

FIG.3.

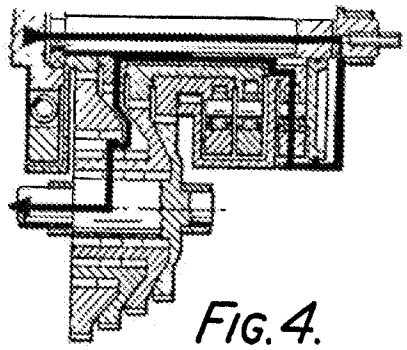

FIG.4.

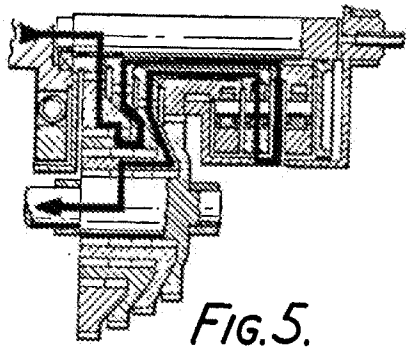

FIG.5.

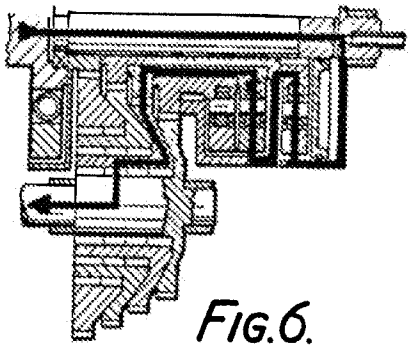

FIG.6.

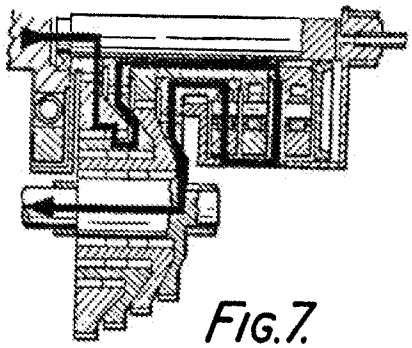

FIG.7.

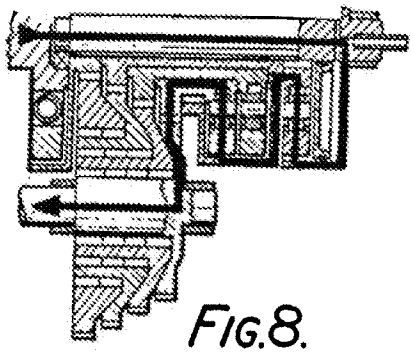

FIG.8.

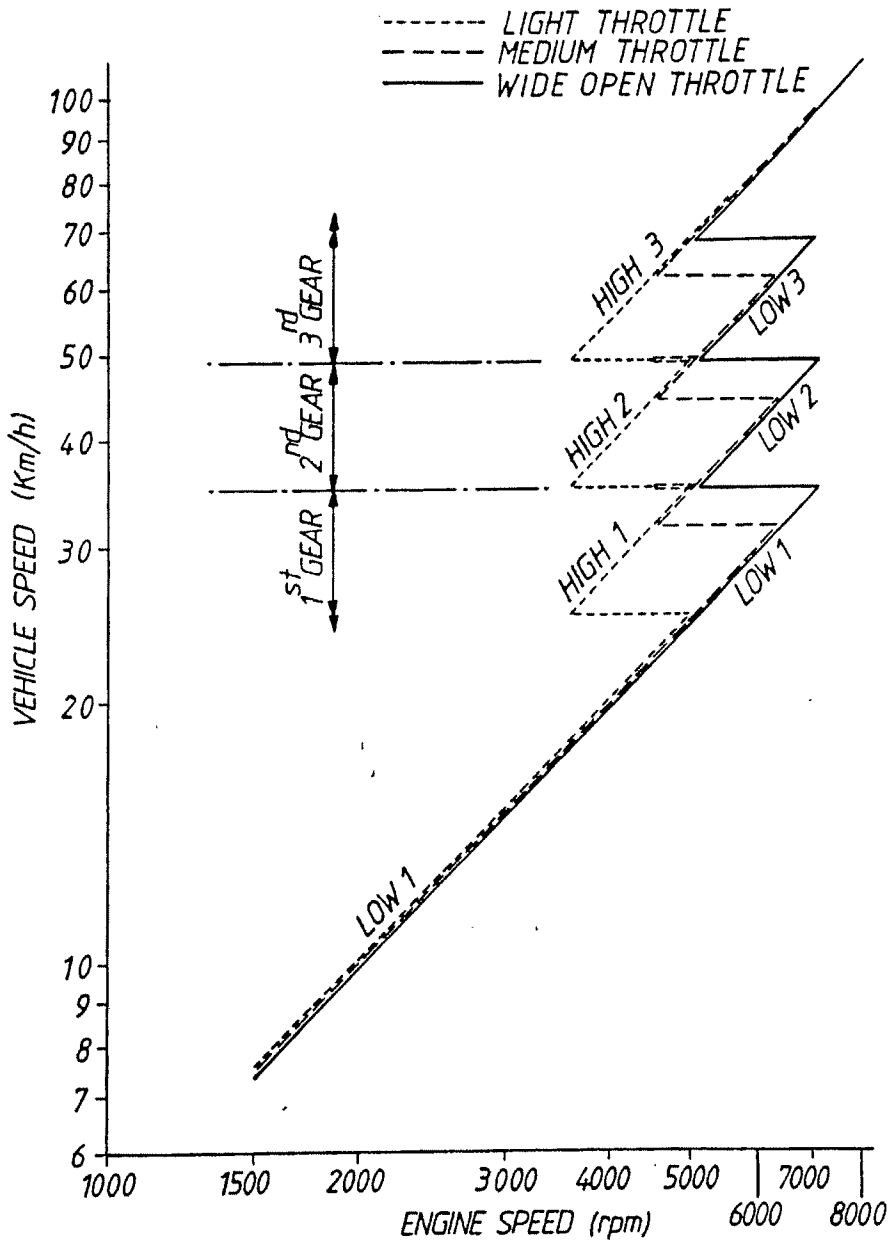
LIGHT THROTTLE
MEDIUM THROTTLE
WIDE OPEN THROTTLE
VEHICLE SPEED (Km/h)
100
90
80
70
60
50
40
30
20
10
9
8
7
6
1000
1500
2000
3000
4000
5000
7000
6000
8000
ENGINE SPEED (rpm)
3rd GEAR
2nd GEAR
1st GEAR
HIGH 3
LOW 3
HIGH 2
LOW 2
HIGH 1
LOW 1
LOW 1

FIG.9.

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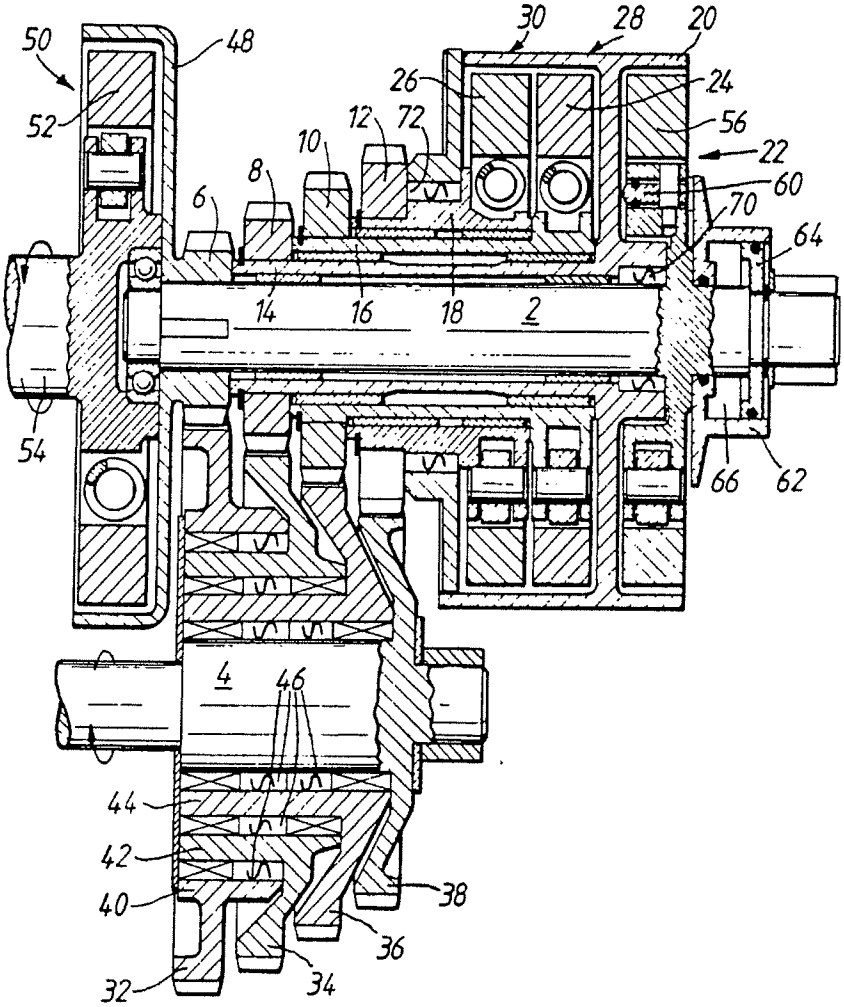

FIG.10.

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"AUTOMATIC GEARBOXES"

The present invention relates to automatic gearboxes, in particular for use with motorcycles of all types including those of small type known as mopeds and scooters.

Motorcycles are known with an automatic gearbox which uses centrifugal clutches to change the gear ratios. The changes in gear ratios occur at predetermined engine speeds or at predetermined road speeds regardless of the desired rate of acceleration.

It is desirable that when the throttle is mostly or fully open the engine speed should be allowed to rise to a higher value than when the throttle is only partly open so as to maximise the acceleration of the vehicle and minimise the time taken to reach a given road speed. The gearbox disclosed in British Patent No. 2081823 B partially meets this objective by ensuring that under rapid acceleration, that is to say under heavy engine load, the change from second gear to top i.e. third gear occurs at higher speed than under gentle acceleration.

It is an object of the invention to provide an automatic gearbox which is both compact and simple, which uses centrifugal clutches to change the gear ratios automatically and does so over the entire range of gear ratios in a manner which takes account of the desired rate of acceleration whereby a higher enginge speed is reached in each gear when accelerating rapidly than when accelerating gently.

According to the present invention an automatic gearbox includes an input shaft and an output shaft,

the input shaft carrying a first input gear wheel connected to rotate with it; second to nth input gear wheels carried by respective secondary shafts which are rotatable with respect to and coaxially with the input shaft and with respect to each other; the secondary shaft of the second input gear wheel being connected to rotate with the outer half of a first centrifugal clutch and the remaining secondary shafts being connected to rotate with the inner half of respective second centrifugal clutches, the outer halves of all the second centrifugal clutches being connected to rotate together, the other half of the first centrifugal clutch being connected to rotate with the input shaft, the first to nth input gear wheels meshing with first to nth output gear wheels respectively, which are rotatable with respect to and coaxially with the output shaft and with respect to each other in one direction only, one-way clutches being provided which prevent relative rotation thereof in the other direction; the first centrifugal clutch including engaging means movable under the action of centrifugal force to transmit torque between its inner half and its outer half, and adjustable resistance means exerting a force in opposition to the centrifugal force whose magnitude is a function of the torque transmitted by the input shaft.

The secondary shaft of the second input gear wheel may be connected to rotate with the outer half of the first centrifugal clutch which may also be connected to rotate with the outer halves of the second centrifugal clutches. It is however preferred that the secondary shaft of the second input gear wheel is connected to rotate with the inner half of the first centrifugal clutch and the outer halves of the second centrifugal

clutches.

Thus a gearbox in accordance with the present invention includes (n-1) centrifugal clutches of which one engages at a speed which is dependent on the torque transmitted by the input shaft, that is to say on the engine load, whilst the remainder engage at a predetermined speed of the output shaft, that is to say, at a predetermined road speed and hence indirectly at a predetermined engine speed. In somewhat over-simplified terms the gearbox may be considered to constitute a speed-sensitive gearbox in series with a load-sensitive gearbox. Thus the gearbox is load sensitive over substantially its entire range of gear ratios. The n meshing pairs of input and output gear wheels provide (n-1) speed-sensitive gear ratios whilst the load-sensitive first centrifugal clutch effectively switches the gearbox between 'high' and 'low' ratios whereby the gearbox has a total of 2(n-1) gear ratios. The first centrifugal clutch engages and disengages at input speeds which are sensitive to engine load.

The resistance means preferably comprises one or more springs acted on by a movable member which moves in a direction to increase the force exerted by the springs when the torque transmitted by the input shaft increases, that is to say when the engine load increases. The gearbox may include a bell crank associated with the or each spring, of which one arm acts on the spring and the other arm is acted on by the movable member. In a preferred embodiment the movable member constitutes a piston or cylinder which, in use, is acted on by a fluid at a pressure which is a function of the torque transmitted by the input shaft. This pressure is conveniently the pressure in the inlet

manifold of the engine to which the gearbox is connected, or a pressure indicative of the said inlet manifold pressure, since the pressure in the inlet manifold is representative of the load to which the engine is subjected and thus of the torque transmitted by the input shaft.

In the preferred embodiment the output gear wheels are carried by respective tertiary shafts coaxial with the output shaft, the one-way clutches being provided between at least each adjacent pair of the first to (n-1)th tertiary shafts. The nth output gear wheel is conveniently integral with the output shaft which in this case will constitute the nth tertiary shaft.

It is preferred that the ratio of the teeth on the input and output gear wheels of the first to nth meshing pairs of input and output gear wheels progressively increases as 'n' increases, preferably geometrically.

It is convenient if the gearbox can be selectively disconnected from the engine, that is to say, if the gearbox has a neutral gear whereby the engine can be started whilst the motorcycle is stationary and whereby the motorcycle can be reversed or pushed slowly forward by the cyclist to manoeuvre the motorcycle whilst the engine is running at idling speeds. For this purpose the input shaft is preferably connected to a further shaft, which may be the engine crank shaft, via a connecting clutch which is preferably a centrifugal clutch so that the entire operation of the gearbox is automatic.

It is preferred that there is a one-way clutch between the secondary shaft of the nth input gear wheel and the connected outer drums, i.e. outer halves, of

the second centrifugal clutches whereby the nth input gear wheel cannot rotate faster than the connected outer halves of the second centrifugal clutches. It is preferred also that there is a one-way clutch between the input shaft and the secondary shaft of the second input gear wheel whereby the connected outer halves of the second centrifugal clutches cannot rotate faster than the input shaft. The effect of these additional one-way clutches is to cause the motorcycle to drive the engine when the engine throttle is closed, thereby providing a braking effect on the motorcycle until the speed of the engine falls to a point where the connecting clutch automatically disconnects the engine from the gearbox.

As mentioned above, the gearbox will provide a total of 2(n-1) gear ratios but it is preferred that at least one gear ratio in the 'high ratio' mode is the same as a gear ratio in the 'low ratio' mode.

The provision of a plurality of meshing pairs of gear wheels coaxial with the input and output shafts, respectively, coupled with the provision of speed-sensitive centrifugal clutches and a load-sensitive centrifugal clutch coaxial with the input shaft results in a gearbox which is not only load-sensitive over substantially its entire range but also can be manufactured to be extremely compact.

Further features and details of the invention will be apparent from the following description of two specific embodiments which is given by way of example with reference to the accompanying drawings in which:-

Figure 1 is a longitudinal sectional view of a gearbox in accordance with the invention for use in a motorcycle;

Figure 2 is a diagrammatic view of the load-sensitive actuating mechanism of the load-sensitive clutch;

Figures 3 to 8 are views of the lower half of the gearbox of Figure 1, but on a smaller scale, showing the power flowpath through the gearbox in low first, second and third gears and high first, second and third gears, respectively;

Figure 9 is a graph of engine speed against vehicle speed for a motorcycle fitted with the gearbox showing the gear change regime at different throttle openings; and

Figure 10 is a view similar to Figure 1 of a modified construction of gearbox in which the same reference numerals are used to designate similar components.

Referring firstly to Figure 1, the gearbox includes an input shaft 2 and an output shaft 4 parallel to it. Extending around the input shaft 2 and keyed to rotate with it is a first input gear wheel 6 with 20 teeth. Also extending around the input shaft are second, third and fourth input gear wheels 8, 10 and 12 with 26, 33 and 40 teeth respectively which are carried by respective coaxial annular secondary shafts 14, 16 and 18, respectively, which are separated from one another and from the input shaft by bearings and can rotate with respect to one another and with respect to the input shaft. The secondary shaft 14 is integral with the inner members or weights 56, that is to say the inner half, of a load-sensitive centrifugal clutch, which is generally designated 22 and will be described in more detail below. The secondary shafts 16 and 18 are connected to rotate with the inner members or

weights 24 and 26, that is to say the inner half, respectively of two further centrifugal clutches, generally designated 28 and 30, of conventional speed-sensitive radially acting type. The outer halves or drums of these further clutches are integral with one another and thus constitute a single unit and are designated with the single reference numberal 74. The drum 74 is connected to rotate with the secondary shaft 14.

The input gear wheels 6, 8, 10 and 12 are meshed with first to fourth output gear wheels 32, 34, 36 and 38, respectively, which have 65, 59, 52 and 45 teeth, respectively. The fourth output gear wheel 38 is connected to rotate with the output shaft 4 and in this case is integral with it. The remaining output gear wheels 32, 34 and 36 are carried by respective annular tertiary shafts, 40, 42 and 44 which are rotatable with respect to one another and the output shaft 4. Each adjacent pair of tertiary shafts is separated by one or more bearings and by one or more one-way clutches, in this case sprag clutches 46 which permit relative rotation in one direction only.

Although not essential, it is desirable that the gearbox has a neutral gear and for this reason the first input gear wheel 6 is integral with the drum 48 of a further centrifugal clutch 50. The weights 52 of the clutch 50 are connected to rotate with a primary shaft 54 which generally constitutes the crank shaft of the engine to which the gearbox is connected.

Referring now to Figure 2, the load-sensitive clutch 22 includes two fly weights 56 which are urged outwardly by centrifugal force and inwardly by springs 58 which are connected to one arm of respective bell

cranks 60. The other arm is acted on by a movable piston 62 which cooperates with a fixed cylinder 64. The piston extends around the input shaft 2 and is sealed to it. The cylinder space 66 communicates with a fluid line 68 whose pressure is a function of the load to which the engine is subject. The inlet manifold pressure is a good indication of the engine load since as the load falls the inlet manifold pressure falls also towards zero. The fluid line may thus be connected to the inlet manifold or to a source of pressurised fluid whose pressure varies with that of the inlet manifold.

If the engine load increases the pressure in the inlet manifold and thus in the cylinder space 66 increases also. This results in leftward movement of the piston 62 (as seen in Figure 2) and thus in an increase in the force exerted by the springs 58. This results in turn in an increase in the rotational speed needed before the weights 56 engage the drum 20 whereby the speed at which the clutch 22 engages is a function of the engine load.

A sprag clutch 70 situated between the secondary shaft 14 of the second input gear wheel 8 and the input shaft 2 ensures that the clutch drum 20 cannot rotate faster than the input shaft. A further sprag clutch 72 between the clutch drum 74 and the secondary shaft 18 of the fourth input gear wheel 12 ensures that gear wheel 12 cannot rotate faster than clutch drum 74. When engine braking is required, i.e. when the throttle is closed, output shaft 4 drives gear wheel 38, gear wheel 12, shaft 18, sprag clutch 72, clutch drum 74, sprag clutch 70, input shaft 2, and thereby drives the engine via connecting clutch 50 until the connecting

clutch disconnects the engine from the gearbox at a predetermined engine speed.

The mode of operation of the gearbox is dependent on the engine load and will therefore be described under light, medium and full acceleration. Consider a continuous acceleration of the motorcycle which causes the gearbox to operate in each gear ratio in turn:

During a light-throttle acceleration the engine speed steadily increases until the connecting clutch 50, which constitutes the first gear clutch, engages and the input shaft 2 then rotates at engine speed. The gear wheel 6 thus directly drives the gear wheel 32 which in turn drives the gear wheels 34, 36 and 38, because the sprag clutches between them lock, and thus drives the output shaft. This is 'low first' gear and the power flow is as shown in Figure 3. At the same time the input gear wheels 8, 10 and 12 are driven by the output wheels 34, 36 and 38 and, due to the respective tooth ratios, the fastest of the disengaged clutches is the load-sensitive clutch 22.

As the engine speed rises the clutch 22 is the first to engage which locks the drum 20 and connects the gear wheel 8 to the input shaft. Drive is now via the gear wheels 8 and 34. The output gear wheels 36 and 38 are caused to rotate also by the sprag clutches between the shafts 42, 44 and 4 whilst the gear wheels 6 and 32 are unloaded and the sprag clutch between the shafts 40 and 42 slips. This is 'high first' gear and the power flow is shown in Figure 4. The vehicle speed cannot respond immediately so the engine speed falls temporarily below that in 'low first' gear.

As the speed of the vehicle continues to increase the fastest of the disengaged clutches, namely the

second gear clutch 28, engages and the clutch 22 remains engaged. The input gear wheels 6, 8 and 10 are all driven at engine speed and thus output gear wheels 32 and 34 are free wheeling. Output gear wheel 32 runs slower than output gear wheel 34 which in turn runs slower than output gear wheel 36. The power flow is via the gear wheels 10 and 36. This is 'high second' gear which is engaged at a predetermined vehicle speed independent of engine load (see Figure 6). The vehicle speed cannot respond immediately and thus the engine speed falls below that in 'high first' gear.

The engine speed continues to rise until the third gear clutch 26 engages and the power is then transmitted through the gear wheels 12 and 38 and all the input gear wheels rotate at engine speed whilst the output gear wheels 32, 34 and 36 are unloaded. This is 'high third' gear and the power flow is shown in Figure 8. Once again the engine speed falls temporarily and the acceleration continues up to the limiting speed of the vehicle under light throttle.

Under medium throttle acceleration the changing of the gear ratios follows a different pattern. Initially, 'low first' gear is engaged in the same manner as under low throttle acceleration. The gearbox then switches to 'high first' gear, as before, but it does so at a higher engine speed than at light throttle because the engagement speed of the load-sensitive clutch 22 is higher than at light throttle. Acceleration continues.

At a predetermined vehicle speed the second gear clutch 28 engages as before to produce 'high second' gear whereby the power flows to the output shaft via gear wheels 10 and 36. The engine speed is therefore

forced to fall by an amount which is determined by the change in gear ratio, i.e. to a speed which is below the speed at which the load-sensitive clutch 22 can remain in engagement. The clutch 22 thus disengages and the input shaft is momentarily disconnected from the output shaft. The engine and gear wheels 6 and 32 thus speed up rapidly until the sprag clutch 46 between the output tertiary shafts 42 and 40 locks up. This connects the engine to the centrifugal clutch drum 74 via gear wheels 6, 32, 34, 8 and shaft 14. The drive then continues as before via centrifugal clutch 24, shaft 16, and output shaft 4. (Sprag clutch between the tertiary shaft 44 and the output shaft 4 is locked). This is 'low second' gear (Figure 5) which ideally has the same gear ratio as 'high first' gear so the engine speeds up and returns again to a speed which is equivalent to the 'high first' gear, having momentarily changed to 'high second' gear. It is to be noted that the sprag clutch between the tertiary shafts 42 and 44 is free wheeling in 'low second' gear and clutch 22 is disengaged.

As the acceleration continues the engine speed rises until the load-sensitive clutch 22 engages and the gearbox is then in 'high second' gear. As this occurs the engine speed falls by a proportion dependent on the change in gear ratio. The engine speed continues to rise until the third gear clutch 30 engages. This causes the gearbox to change rapidly from 'high second' to 'high third' to 'low third' gear (Figure 7) (which is the same as 'high second' gear). The engine speed continues to rise until the load-sensitive clutch 22 engages and the gearbox is then in 'high third' gear.

Under full or wide-open throttle acceleration the pattern of gear changing is again different. Initially, 'low first' gear is engaged, as before, but movement of the piston 62 ensures that the load-sensitive clutch 22 does not engage and the first clutch to engage is thus the clutch 28. When this happens the gearbox is in 'low second' gear and power is transmitted via gear wheels 6, 32, 34 and 8, shaft 14, clutch 28, shaft 16 and the gears wheels 10 and 36. As the engine and vehicle speeds rise the load-sensitive clutch 22 remains disengaged until the third gear clutch 30 engages and the gearbox is then in 'low third' gear. The engine and vehicle speeds continue to rise until the load-sensitive clutch 22 engages and the gearbox is then in 'high third' gear.

If the throttle opening should be changed part way through one of the gear change regimes described above, the gear change regime will change to that appropriate to the degree of throttle opening, that is to say, to the engine load now pertaining. Thus if the engine changes from light acceleration to full acceleration when in 'high first' gear, the pressure in the manifold rises and the load-sensitive clutch 22 engages whereby the gearbox shifts down to 'low first' gear. Similarly, if the engine changes from light to full acceleration in 'high second' gear the gearbox shifts down to 'low second' gear.

When the engine throttle is closed it is desirable to have engine braking whereby the speed of the motorcycle may be reduced without using the motorcycle's brakes. When the motorcycle is running at high speeds in 'high third' gear, closing the throttle causes the output shaft 4 to drive the gearbox and the engine.

Only the output gear wheel 38 is loaded by the output shaft and the sprag clutches 46 prevent the output gear wheels 32, 34 and 36 from being loaded. The output gear wheel 38 drives the input gear wheel 12 and secondary shaft 18 drives the clutch drum 74 via clutch 26, clutch drum 74 drives the input shaft 2 via load-sensitive clutch 22, and the input shaft 2 drives the engine via connecting clutch 50 thereby maintaining the gearbox in 'high third' gear. Below a predetermined speed the load-sensitive clutch 22 disengages and the sprag clutch 70 locks up, so that the clutch drum 74 then directly drives the input shaft 2. The gearbox therefore remains in 'high third' ratio. As the speed of the motorcycle continues to fall, clutch 26 disengages because the vehicle speed has fallen too low, but sprag clutch 72 then locks so that shaft 18 drives the drum 74 directly, bypassing clutch 26. Again the gearbox remains in 'high third' ratio. At an even lower vehicle speed, clutch 24 disengages, but this has no effect since it is bypassed via sprag clutches 72 and 70. Finally, a low speed is reached where the clutch 50 disconnects the engine from the gearbox and engine braking ceases.

If the throttle is closed when the gearbox is operating in other gear ratios, then engine speed will fall to the equivalent of running in 'high third' gear and thereafter the gearbox will operate in 'high-third' ratio braking mode.

In the modified construction of gearbox shown in Figure 10 the outer halves or drums of the speed

sensitive centrifugal clutches 30 and 28 and the load-sensitive centrifugal clutch 22 are integral and thus rotate together. The inner members or weights 56 of the clutch 22 are connected to be rotated by the input shaft 2. This embodiment of the invention provides easier access to the inner members of the clutch 22.

CLAIMS

1. An automatic gearbox including an input shaft and an output shaft, the input shaft carrying a first input gear wheel connected to rotate with it; second to nth input gear wheels carried by respective secondary shafts which are rotatable with respect to and coaxially with the input shaft and with respect to each other; the secondary shaft of the second input gear wheel being connected to rotate with one half of a first centrifugal clutch and the remaining secondary shafts being connected to rotate with the inner half of respective second centrifugal clutches, the outer halves of all the second centrifugal clutches being connected to rotate together, the other half of the first centrifugal clutch being connected to rotate with the input shaft, the first to nth input gear wheels meshing with first to nth output gear wheels respectively, which are rotatable with respect to and coaxially with the output shaft and with respect to each other in one direction only, one-way clutches being provided which prevent relative rotation thereof in the other direction; the first centrifugal clutch including engaging means movable under the action of centrifugal force to transmit torque between its inner half and its outer half, and adjustable resistance means exerting a force in opposition to the centrifugal force whose magnitude is a function of the torque transmitted by the input shaft.

2. A gearbox as claimed in Claim 1 in which the secondary shaft of the second input gear wheel is

connected to rotate with the outer half of the first centrifugal clutch which is also connected to rotate with the outer halves of the second centrifugal clutches.

3. A gearbox as claimed in Claim 1 in which the secondary shaft of the second input gear wheel is connected to rotate with the inner half of the first centrifugal clutch and the outer halves of the second centrifugal clutches.

4. A gearbox as claimed in any one of the preceding claims in which the resistance means comprises one or more springs acted on by a movable member which moves in a direction to increase the force exerted by the springs when the torque transmitted by the input shaft increases.

5. A gearbox as claimed in Claim 4including a bell crank associated with the or each spring, of which one arm acts on the spring and the other arm is acted on by the movable member.

6. A gearbox as claimed in Claim 4 or Claim 5 in which the movable member constitutes a piston or cylinder which, in use, is acted on by a fluid at a pressure which is a function of the torque transmitted by the input shaft.

7. A gearbox as claimed in any one of the preceding claims in which the output gear wheels are carried by respective tertiary shafts coaxial with the output shaft, the one-way clutches being provided

between each adjacent pair of the 1st to (n-1)th tertiary shafts.

8. A gearbox as claimed in Claim 7 in which the nth output gear wheel is integral with the output shaft which thus constitutes the nth tertiary shaft.

9. A gearbox as claimed in any of the preceding claims in which the ratio of the teeth on the input and output gear wheels of the first to nth meshing pairs of input and output gear wheels progressively increases as 'n' increases.

10. A gearbox as claimed in Claim 9 in which the ratio of the teeth on the first to nth meshing pairs of gear wheels increases in a geometric progression.

11. A gearbox as claimed in any one of the preceding claims in which the drive to the input shaft is connected to a further shaft via a further clutch.

12. A gearbox as claimed in Claim 9 in which the further clutch is a centrifugal clutch.

13. A gearbox as claimed in any one of the preceding claims which includes a one-way clutch between the secondary shaft of the nth input gear wheel and the connected outer halves of the second centrifugal clutches whereby the nth input gear wheel cannot rotate faster than the connected outer halves of the second centrifugal clutches.

14. A gearbox as claimed in any one of the preceding claims which includes a one-way clutch between the input shaft and the secondary shaft of the second input gear wheel whereby the connected outer halves of the second centrifugal clutches cannot rotate faster than the input shaft.

15. A gearbox as claimed in any one of the preceding claims in which, when the power flow from the input shaft to the output shaft flows through the first centrifugal clutch, at least one gear ratio between the input and output shafts is the same as a gear ratio when the power flow from the input shaft to the output shaft does not flow through the first centrifugal clutch.

16. An automatic gearbox substantially as specifically herein described with reference to Figure 1 or 10, optionally in conjunction with Figure 2, of the accompanying drawings.

CLAIMS

Amendments to the claims
have been filed as follows

1. An automatic gearbox including an input shaft and an output shaft, the input shaft carrying a first input gear wheel connected to rotate with it; second to nth input gear wheels carried by respective secondary shafts which are rotatable with respect to and coaxially with the input shaft and with respect to each other; the secondary shaft of the second input gear wheel being connected to rotate with one half of a first centrifugal clutch and the remaining secondary shafts being connected to rotate with the inner or centrifugally-sensitive half of respective second centrifugal clutches, the outer or non-centrifugally-sensitive halves of all the second centrifugal clutches being connected to rotate together and connected to rotate with the secondary shaft of the second input gear, the other half of the first centrifugal clutch being connected to rotate with the input shaft, the first to nth input gear wheels meshing with first to nth output gear wheels respect-ively, which are rotatable with respect to and coaxially with the output shaft and with respect to each other in one direction only, one-way clutches being provided which prevent relative rotation thereof in the other direction; the first centrifugal clutch including engaging means movable under the action of centrifugal force to transmit torque between its inner half and its outer half, and adjustable resistance means exerting a force in opposition to the centrifugal force whose magnitude is a function of the torque transmitted by the input shaft.

2. A gearbox as claimed in Claim 1 in which the secondary shaft of the second input gear wheel is connected to rotate with the outer half of the first centrifugal clutch.

3. A gearbox as claimed in Claim 1 in which the secondary shaft of the second input gear wheel is connected to rotate with the inner half of the first centrifugal clutch.

4. A gearbox as claimed in any one of the preceding claims in which the resistance means comprises one or more springs acted on by a movable member which moves in a direction to increase the force exerted by the springs when the torque transmitted by the input shaft increases.

5. A gearbox as claimed in Claim 4including a bell crank associated with the or each spring, of which one arm acts on the spring and the other arm is acted on by the movable member.

6. A gearbox as claimed in Claim 4 or Claim 5 in which the movable member constitutes a piston or cylinder which, in use, is acted on by a fluid at a pressure which is a function of the torque transmitted by the input shaft.

7. A gearbox as claimed in any one of the preceding claims in which the output gear wheels are carried by respective tertiary shafts coaxial with the output shaft, the one-way clutches being provided

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